

COMPARISON OF GERB AND CERES SW RADIANCES BETWEEN 2004 - 2012

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SUMMARY

AIM: To study the change in relative calibration of the reflected solar radiances (RSW) from GERB (Ed 1) (Harries et al. 2005) and CERES (Ed 3a) (Wielicki et al. 1996) over the time period May 2004 to December 2012. This work is part of a larger effort seeking to produce a stable homogenous observational record from the GERB instruments.

KEY FINDINGS: The relative calibration between GERB and CERES and its evolution is best considered as a function of the spectral properties of the scene. The unfiltered to filtered radiance ratio provides a good proxy for this.

Assuming that CERES FM1 (Ed 3) RSW radiances are a stable reference, the solar radiances from GERB show a progressive darkening over their operational lifetime. The rate of darkening appears approximately linear in time but depends on the spectral properties of the scene, being most severe for the bluest scenes.

The rate of change in relative calibration for ~95% of the scenes is in the range 0.6 to 1.8% per year.

See Parfitt et al. 2016 for full details.

DATA SELECTION

CERES SSF Edition 3a radiances are matched to the GERB Edition 1 HR radiances. Observations must be of the same location, separated by less than 7.5 minutes in time and with a viewing vector within $\pm 8^\circ$. Only points with viewing zenith angle and solar zenith angle $< 60^\circ$ are considered.

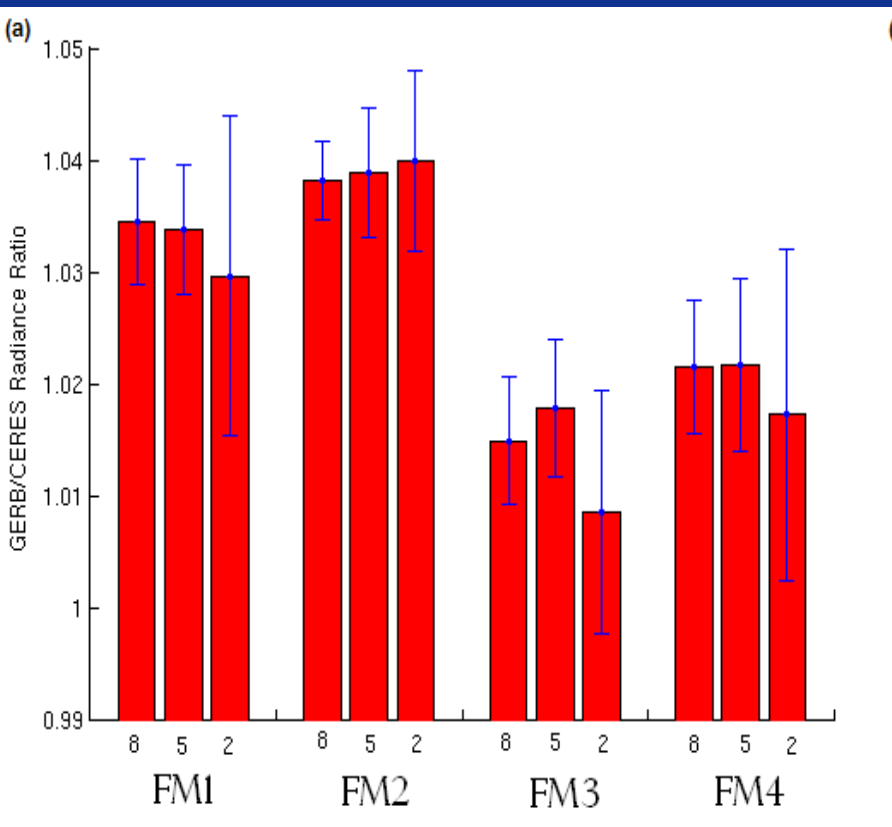


FIGURE 1 RSW GERB 2 / CERES radiance ratio for matched points. Ratio of the mean of all matched points is shown for each CERES FM as a function of the maximum allowed angular difference between the views. Results shown for angular limits 8° , 5° and 2° for CERES SSF Ed 3a and GERB 2 Edition 1 (SWupdate) data for June 2004. Note that the mix of scenes and viewing geometry differs between the different CERES instruments

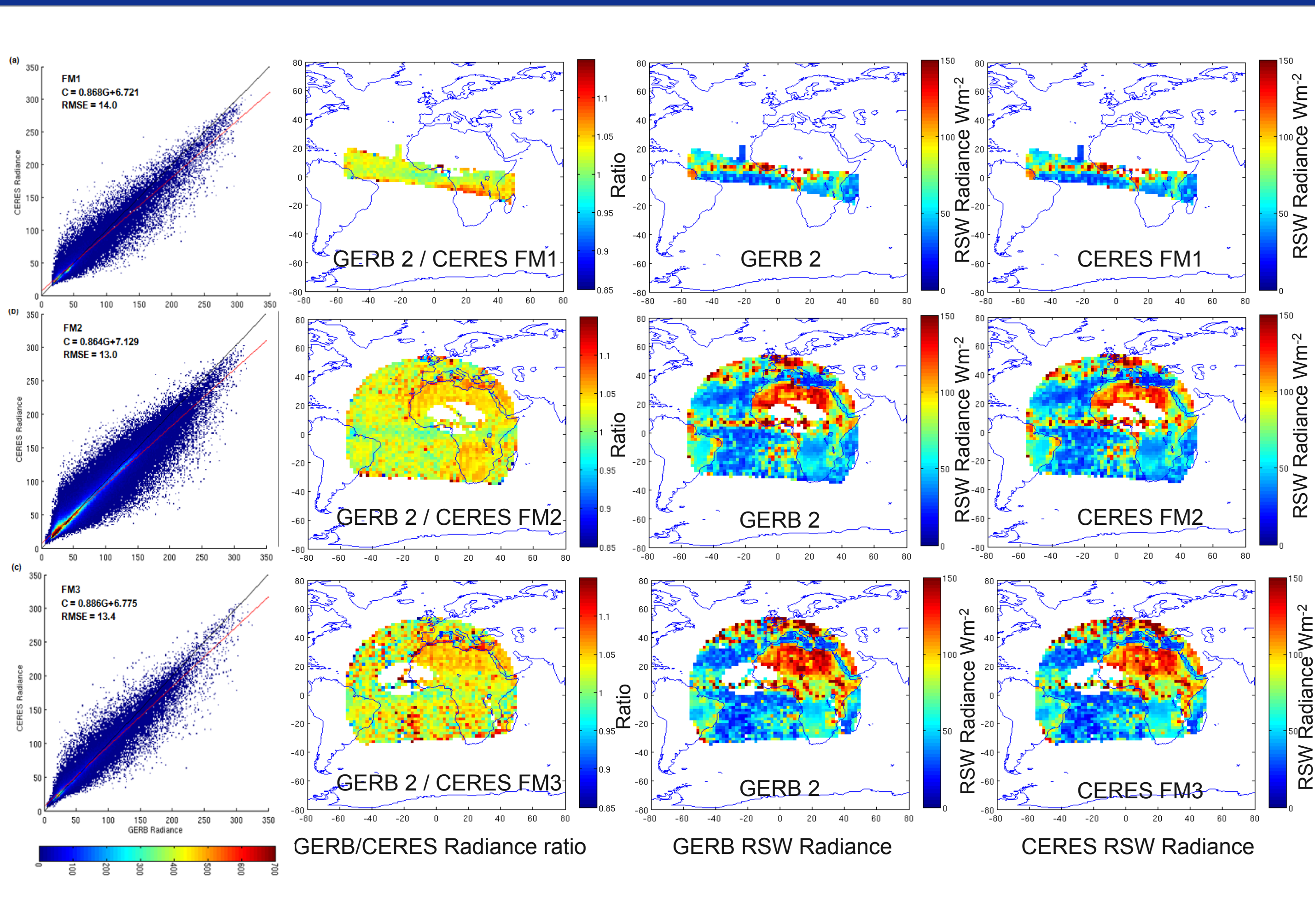


FIGURE 2 RSW GERB 2 / CERES radiance comparison for June 2004. For the geographical comparison, radiances of matched points are averaged into 2° lon/lat bins before calculating a ratio. 2d histograms of the GERB and CERES matched radiances binned according to their value are also shown along with the result of a least squares linear fit to the individual matches. Results for GERB 2 and CERES FM 1, 2, and 3 are shown along with the associated GERB / CERES RSW radiance ratio.

ANALYSING THE COMPARISON

The relative calibration of the GERB and CERES RSW radiances and its evolution was seen to depend on what was being observed. Geographical location, viewing angle or the magnitude of the observed radiance were not found to be good discriminators (Figure 4). Nor was separation by broad scene type such as clear ocean or thick cloud.

Simulations show that the magnitude of the error induced by calibration changes due to a change in instrument response that increases with decreasing wavelength is better predicted by the ratio of unfiltered to filtered radiance than the absolute value of the unfiltered radiance or the scene classification (Figure 3).

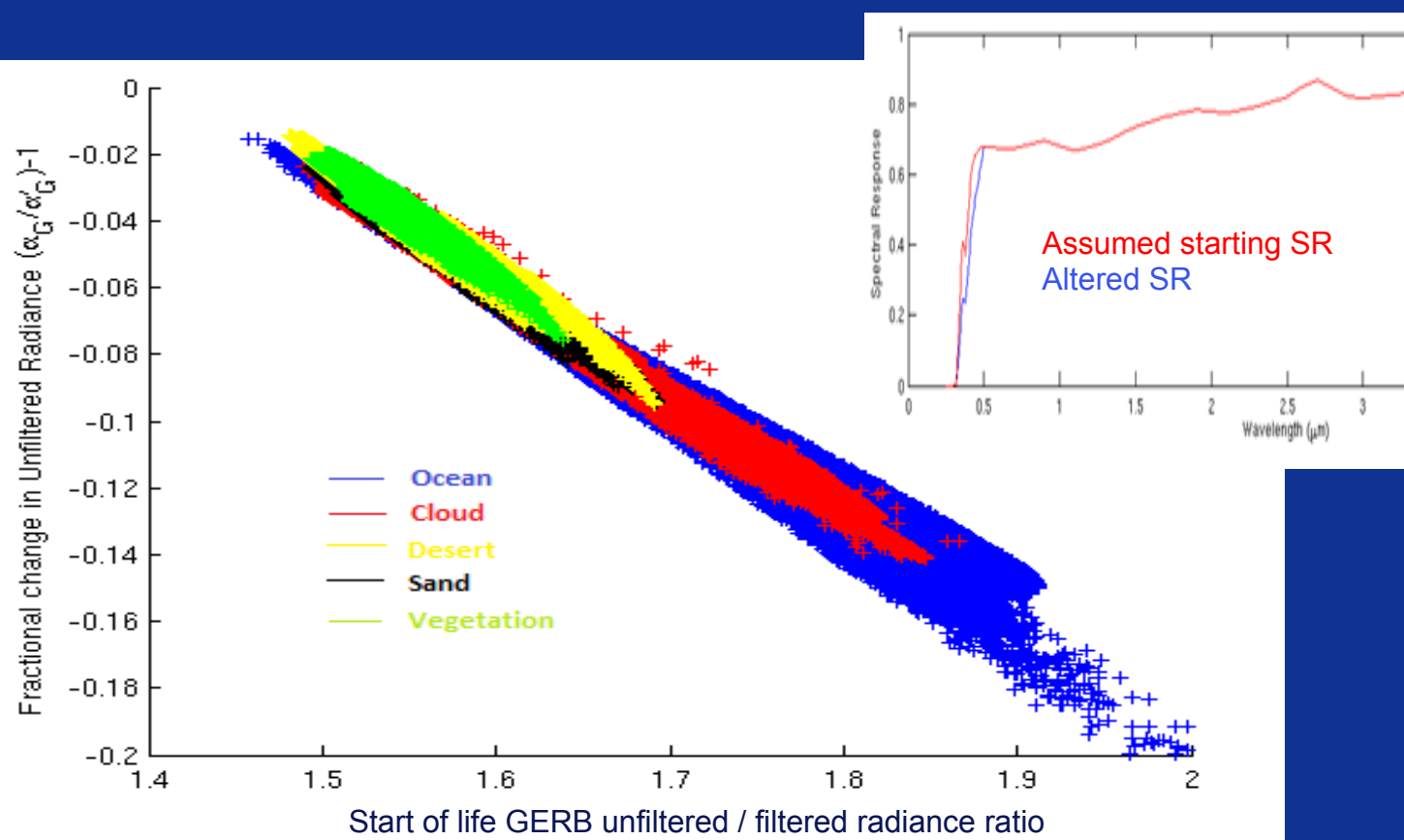
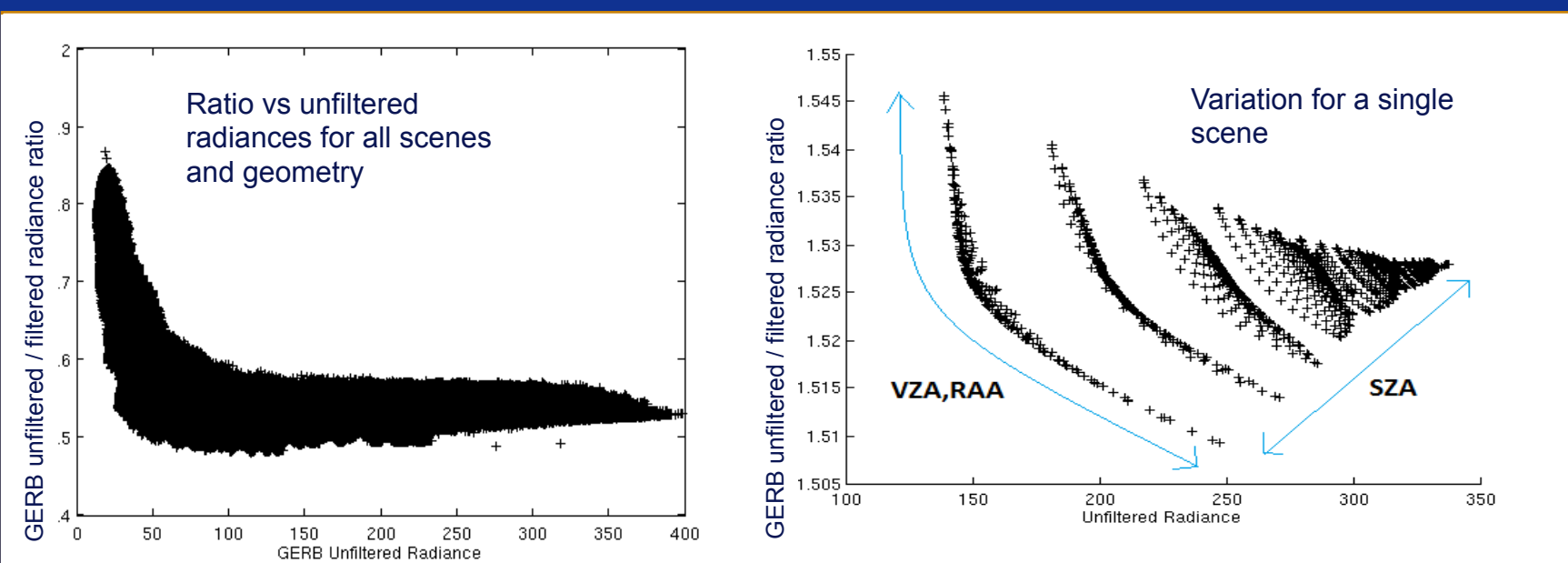


FIGURE 3 Distinguishing power of the unfiltered to filtered radiance ratio. The magnitude of the error caused by an unaccounted for spectrally varying change in the instrument spectral response (shown inset right) is linearly related to the ratio across all scene types and full range of solar and viewing geometry

FIGURE 4 For GERB the unfiltered / filtered radiance ratio is not simply related to unfiltered radiance and varies with viewing and solar geometry for a single scene



INTERPRETATION AND PRACTICAL APPLICATION

Both CERES and GERB use silver coated mirrors, which have a drop in response at the bluest wavelengths. The ratio of unfiltered to filtered radiance thus increases as the spectral distribution of energy of the scene shifts to shorter wavelengths.

The unfiltered to filtered radiance ratio is a proxy for the scene 'colour'.

The CERES unfiltered to filtered RSW radiance ratio was used to classify the matched points. In common with previous comparisons between broadband radiances (Loeb et al, 2006) it enabled the calibration difference between the instruments and the rate of its evolution to be clearly and simply diagnosed.

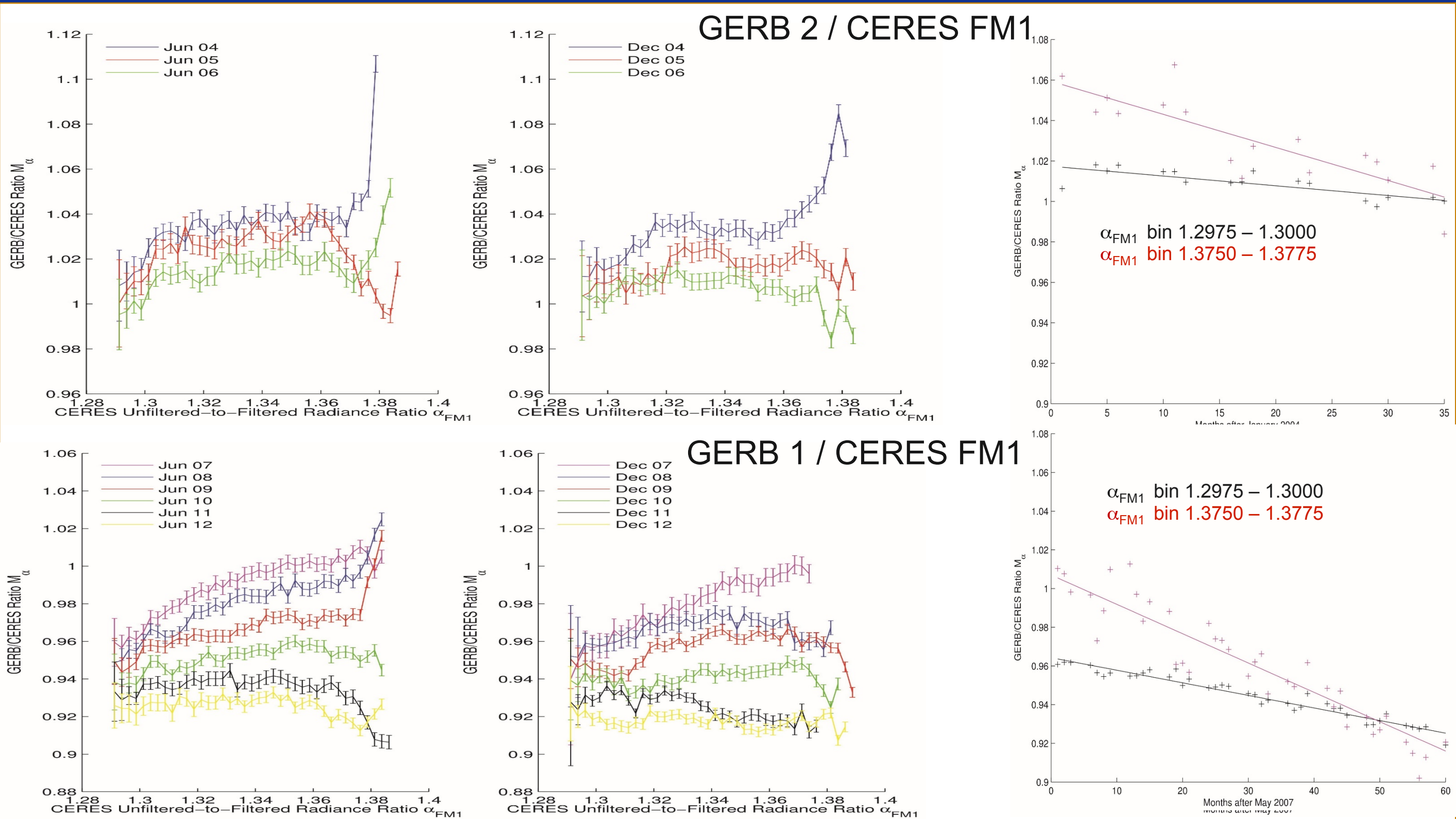


FIGURE 5 GERB/CERES FM1 RSW radiance ratio as a function of CERES unfiltered/filtered radiance and its change over time for GERB 2 (top) and GERB 1 (bottom). Results are shown for all unfiltered/filtered radiance ratios for each June (left) and December (middle). The RSW radiance ratio for all months for two selected unfiltered/filtered radiance ratio bins is also shown (right).

RESULTS

The GERB / CERES RSW radiance ratio and its rate of change varies with scene colour.

At the start of life, the variation is stronger for GERB 1 than GERB 2.

Assuming CERES FM1 Ed3 RSW radiances constitute a stable reference:

- The rate of darkening over time in the GERB 1 RSW is slightly greater than that seen for GERB 2 for most scenes.
- For both GERB instruments the rate of darkening increases as the distribution of energy of the scene shifts to shorter wavelengths (higher unfiltered / filtered ratio).
- For all scenes, the rate of decrease is roughly linear and the increase in the rate with CERES unfiltered/filtered radiance ratio is also approximately linear.
- The rate of decreases in the RSW radiance for ~ 95% of the scenes is in the range 0.6 to 1.8% per year for both GERB 1 and GERB 2

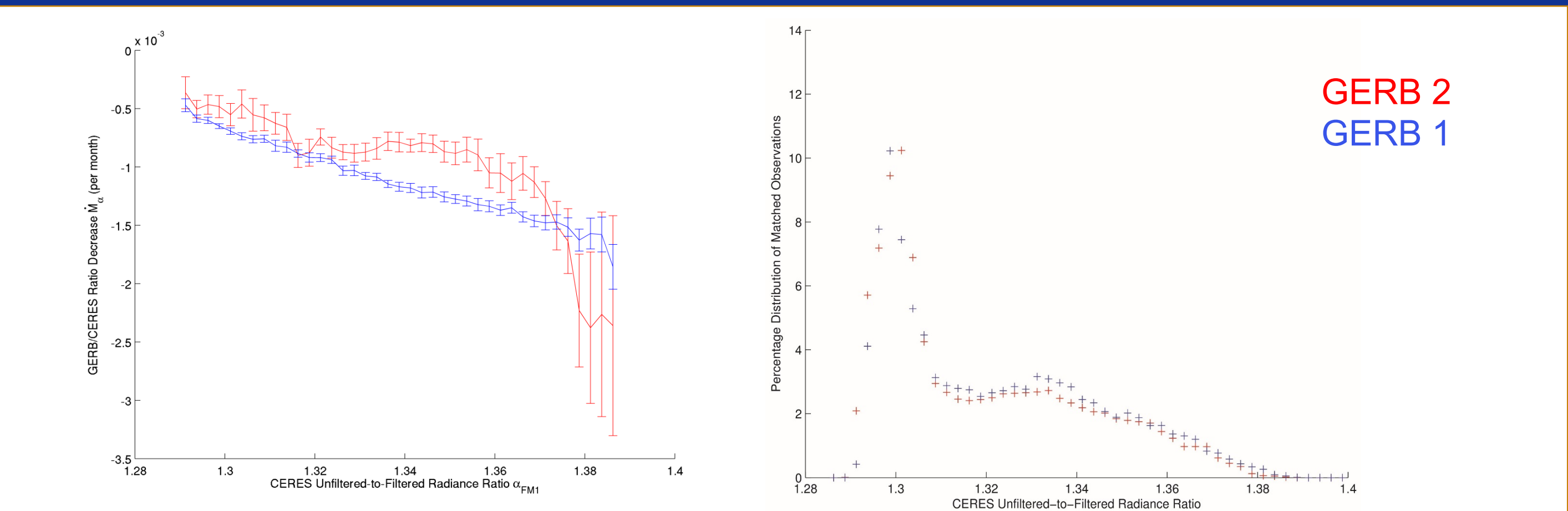


FIGURE 6 Rate of change of the GERB/CERES FM1 RSW radiance ratio as a function of CERES unfiltered/filtered radiance ratio (left). Frequency distribution of the CERES unfiltered/filtered radiance ratio for the comparison (right).

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